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BIOLOGICAL EVALUATION OF OAK TREE DIEBACK AND MORTALITY AT EASTMAN LAKE, MADERA COUNTY, CALIFORNIA

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ABSTRACT

The Eastman Lake Recreation Area was examined in order to determine the causes of an observed increase in oak mortality and to provide Forest Pest Management input to a Management Plan for the area. A recent increase in oak dieback or mortality was not evident. Rather, crown conditions suggested periods of dieback and regrowth over past years. Periods of lower than normal rainfall was suspected as the primary cause of the dieback. Insects and fungi associated with declining trees were of the type found on oaks stressed or weakened by unfavorable growing conditions. Four management alternatives are discussed, including do nothing, remove dead branches, irrigate existing trees, and plant oaks.

INTRODUCTION

At the request of Wayne J. Scholl, District Engineer, U. S. Army Corps of Engineers, Sacramento District, we examined recreation areas at H. V. Eastman Lake on April 3, 1986. We were accompanied during portions of the examination by James Kledzik, Park Ranger, and Joe Holmberg, Forester, Natural Resources Management Unit, Sacramento District.

The objectives of the evaluation were to determine the causes of a perceived increase in oak tree mortality during the past few years, to develop alternatives to minimize continuing loss of tree cover, and to assist in the development of a Management Plan to provide active management of existing and replacement trees at Eastman Lake. Specific information requested during the evaluation for the Management Plan included information on: the relationship, if any, of herbicide use for grass control to the dieback; hazard tree reduction; pruning techniques; and techniques for successful regeneration of native oaks.

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OBSERVATIONS

H. V. Eastman Lake/Buchanan Dam is located in the foothills of the Sierra Nevada, about 25 miles northeast of Chowchilla. The Dam was completed in 1975. Recreational facilities, including a 75-acre developed campground (Codorniz), nondeveloped camping areas, a visitor's center, and day use areas, were constructed around the 1800-acre lake in the late 1970's.

Vegetation in the area consists of tall grass with scattered oak trees. Valley oak is the most common species, with live oak and blue oak also represented. The majority of the oaks appear to be approximately the same age (200 + years) with little or no natural oak regeneration present. Some native oaks, as well as species of Eucalyptus and London plane trees, have recently been planted at the Visitor's Center.

Dieback of oaks was generally common throughout the area. No relationship between past construction activities or use of herbicides and decline of trees was noted. In general, valley oaks exhibited more dieback than blue oaks. In most cases, individual twigs were dying from the tip back. The dieback was general throughout the entire crown of some trees, but restricted to portions of the crown on others. One oak at the Visitor's Center and a few in Codorniz Campground had died within the last year.

Examination of twigs and branches generally revealed a diffuse area of browning rather than any definite margin of cambium death. However, some twigs and smaller branches did have cankers in the form of depressions. Bark cracking and exudation were associated with the cankers. A pathogenic fungus, Coryneum (Seridium) sp., was isolated from these cankers. The presence of a second canker-causing fungus, Diplodia quercina, was suspected on the basis of symptoms, but not confirmed by isolation. Heartrot or decay was common in trunks of cored trees and was evident in large main branches.

Several species of insects were present on oaks in the area. Gall wasps had caused a few leaf and twig galls. Twig galls have the potential to contribute to twig dieback if they are extremely abundant, or if they occur in conjunction with drought. The galls did not appear to be responsible for any significant dieback in this case.

Feeding by the fruittree leafroller, Archips argyrospilus, was widespread, but at low levels. Although there was no indication of heavy feeding in the recent past, heavy feeding for several years could lead to dieback or mortality.

The lower trunks of the dead oaks examined contained larval mines of round-headed borers, Phymatodes sp. These borers are generally found only under the bark of dead or dying oaks. It is unlikely that they made a significant contribution to the death of the trees. No other cambium feeding insects were found on the trees.

DISCUSSION

There does not appear to have been any sudden dieback or mortality of oaks in the area. The insects and fungi associated with the declining trees were secondary-type organisms, normally found on oaks stressed or weakened by unfavorable growing conditions. The distribution of the existing dieback and mortality suggests that construction and maintenence of the facilities, or the use of herbicides, had little influence except in a few obvious cases where construction had removed a large portion of a root system. The general condition of tree crowns in the area indicates that periods of dieback and regrowth have occurred throughout the life of the trees.

The reason for periodic dieback seems to be that the area around Eastman Lake is at the lower edge of the elevational zone which receives adequate precipitation to support native trees. There is enough precipitation during years with average or above average rainfall that most trees will remain alive and grow enough to eventually mask the signs of previous dieback. During periods of below normal precipitation however, many trees will experience drought stress, crown dieback, and a few trees will die. Precipitation records from four weather stations surrounding Eastman Lake indicate very dry conditions during 1976-1977 when there was a severe drought throughout northern California, and also during 1984-1985, just prior to the observation of dieback and mortality (Figure 1).

Although years of low precipitation occur infrequently and the effects on the trees are limited, inadequate moisture will eventually cause both short and long-term impacts on the management of vegetation in the area. Branch dieback can cause a short-term impact in campgrounds or other areas where the public is encouraged to congregate because the dead branches could become safety hazards if not removed. A more long-term impact is likely to result from the fact that, although dry years have periodically caused small reductions in the number of mature trees, there is virtually no regeneration to replace them. The exact combination of events necessary for natural valley oak regeneration is not known, but evidently they do not occur frequently. The lack of oak regeneration in other parts of California is suspected to result from a combination of heavy browsing, pocket gophers, competition from other vegetation, and the erratic, often marginal, rainfall characteristic of the Mediterranean climate. The occurrence of some of the factors possibly involved in the natural establishment of regeneration, such as fire, may be so altered that they no longer occur in the proper combination. If the weather pattern remains the same, and if there is no natural regeneration of oaks, then the existing tree cover will slowly disappear.

MANAGEMENT ALTERNATIVES

1. **Do Nothing.** Periodic dry years will cause branch dieback and occasional mortality. The number of trees present will gradually be reduced, but it will be decades before tree loss should cause a major impact on recreation. Some of the dead trees or branches will have the potential to cause property loss or personal injury if they fail.

2. **Remove Dead Branches.** Removal of dead trees and branches in areas where people are encouraged to park or congregate will lower the probability of an accident caused by tree failure. Trees in areas which receive only occasional or infrequent use have a low probability of striking a target and, as a consequence, are usually considered a low priority for treatment. Pruning cuts made just beyond the branch collar, which is a swelling where the branch joins the trunk, will heal the fastest and have the lowest probability of infection by decay fungi. Pruning wounds are best left untreated. The availabe tree wound dressings that have been tested are useless in preventing fungal infection and interfere with the formation of callus during the healing process. Pruning of dead branches will also stop the progression of cankers downward into larger limbs, and may reduce fungus inoculum available for further infections.

3. **Irrigate Existing Trees.** It would be possible to postpone the loss of certain trees in developed areas by delivering supplemental water to the root zone during dry spring periods. There is probably no need to irrigate during years with average or above averge precipitation, except that regular useage might make it easier to maintain the system. Water can be delivered to the zone useful to the tree roots by means of pipes with perforated tips inserted 18 to 24 inches deep in the soil under the tree crown. The flow from a drip irrigation system can be adjusted so that the water level in the pipes remains somewhere between dry and overflowing. The pipes can aid in soil aeration at other times of the year and can also be used to deliver liquid fertilizer solution.

Surface irrigation with sprinklers should be avoided. Surface irrigation of oaks tends to stress the trees, encourages infection by Armillaria root disease, and may result in tree death.

4. **Plant Oaks.** Because the mature oaks are slowly dwindling in number and natural replacements do not presently exist, planting seems to be the only method of maintaining the status quo. The current widely scattered occurrence of oaks is probably close to the maximum number that the site can support. The only need for planting would be as replacements for the mature trees which occasionally die. Survival of planted trees in the campground can be enhanced by using the largest planting stock available to reduce accidental damage by recreationists. Until the trees become well-established, they will probably need extra maintenance such as control of gophers, scalping of grass to reduce competition, protection from recreationists and mowers, and supplemental watering.

The native oaks grow much slower than some exotic species that will survive in the area. If there is any attempt to plant exotic trees such as Eucalyptus to quickly provide shade until native oaks become established, it should be with the knowledge that the exotic trees may provide short-term benefits, but may complicate later management plans. Exotic trees grown under harsh conditions sometimes show rapid growth for 10 to 20 years and then rapidly decline and die. Chemicals leached from the foliage of some exotic trees species may make it impossible to grow native plants, including oaks, under or near them.

5. **Establish an Information and Education Program.** A simple and low cost program to educate recreationists about trees could help protect newly-planted ones and reduce damage to those already established. One-page fact sheets

distributed to people registering at campgrounds, informational bulletin boards in campgrounds and small signs near newly-planted trees could all help accomplish this goal.

PEST BIOLOGIES

Oak Canker Fungi

Several canker-causing fungi are associated with oaks. Diplodia quercina infects and girdles oak branches, causing flagging and, eventually, stag-heading in tree crowns. The disease occurs on live, black, and valley oaks in the Sierra foothills. Blue oak is also susceptible. The fungus attacks and kills the sapwood, cambium, and phloem of branches. Infection occurs mainly through wounds, although uninjured petioles can also be infected. Once established, the fungus girdles branches, resulting in the death of distal portions. Fungus fruiting bodies are produced on dead tissues. These produce spores that are spread by rain splash, and probably by insects. Infection apparently occurs mainly in early spring, but symptoms are often most pronounced during hot periods in the summer. Diplodia-caused dieback of branches up to six inches in diameter was first noted in California in 1977. This dieback became increasingly severe through 1981, when it began to decrease; in 1985, however, the disease reappeared.

Coryneum canker has been reported previously on California oaks, but its relation to the widespread Diplodia-caused dieback is unknown. Where Coryneum sp. is associated with other tree species, it acts much the same way as Diplodia. On Monterey cypress, the fungus infects bases of small branches or in branch forks. Resulting cankers grow along a branch and eventually girdle it. Resin flow and bark cracking commonly accompanies canker development. Young 2 to 3 year-old branches may be killed within a year, whereas larger branches may remain alive for 5 to 10 years.

The Diplodia branch dieback appears to increase during periods of drought. Since many diebacks are associated with tree stress, it has been speculated that the severe drought of 1976-1977 was instrumental in Diplodia buildup. The disease declined dramatically until the recent dry spell in 1985, when an apparent increase in disease was observed. Coryneum sp., as most canker-causing fungi, probably acts in much the same way, with more infection occurring on stressed trees. Direct control measures have not been developed for either of these organisms.

Armillaria on Oaks

The fungus Armillaria is widely distributed in soils and usually lives as a saprophyte on dead wood or other organic matter. It is frequently associated with hardwood roots, especially oaks. Healthy oaks are quite resistant to the fungus. This resistance disappears, however, when trees are weakened, stressed, cut, or killed, and Armillaria may then rapidly colonize and decompose roots and sometimes entire root systems. The organic material used as a source of nutrition is called a food base. Stresses that have been linked to increased damage from this root disease include insect defoliation, drought, excessive soil moisture, poor planting techniques, bark beetle attack, air pollution injury and nutrient deficiencies.

With a large food base to utilize, the fungus is aggressive and moves to the roots of nearby trees by means of root contacts and rhizomorphs. Rhizomorphs are structures that resemble black shoestrings and grow like roots through upper soil layers. The predominant method of tree to tree spread in California is via root contact; rhizomorphs are more important and prevalent in other areas of the country.

Armillaria is capable of directly penetrating through the intact root bark of living trees and once it reaches the cambium it usually grows quite rapidly, producing a flat, white, leathery, fan-shaped mycelial mat. Rhizomorphs are often associated with the mat. If the fungus reaches the root collar it girdles the stem and kills the tree. After Armillaria successfully colonizes a root segment or root system, it continues to decay the wood and causes a white to yellowish, wet, stringy rot. This rot does not usually extend more than a few feet above the soil line.

Clusters of mushrooms may be found in the fall at the base of infected dead or dying trees and stumps. These mushrooms, which are edible, may also grow directly out of the soil near the food base. Spores produced by fruiting bodies are not an important source of new infections or long distance spread and are the only known spore stage of the fungus.

Under natural conditions, the fungus does little or no damage to California oak trees. However, trees that receive surface irrigation during the summer, or trees in areas where the soil level has been changed, frequently die. Avoidance of summer irrigations and the maintenance of existing soil levels around established trees will reduce or prevent damage from Armillaria. Any cultural practices that reduce stress and increase tree vigor will reduce the potential for infection.